

## Introduction

- The TOA radiation fluxes and precipitation from reanalyses, including the new NASA reanalysis (MERRA), are compared with those from observation in the LW-SW joint frequency distribution (JFD) domain.
- A metric for evaluating water and energy processes in reanalysis/model is proposed.

## Data used in this study

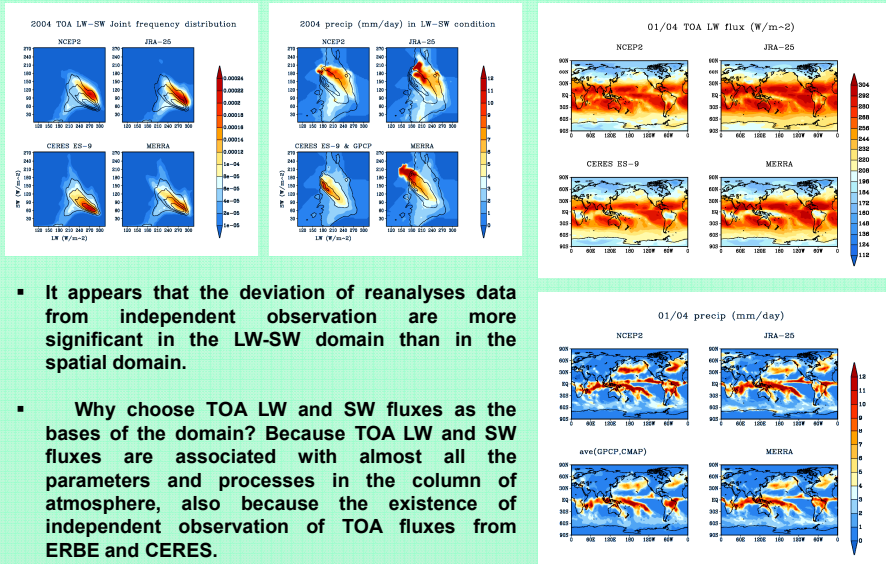
### Reanalyses:

- NCEP-DOE Reanalysis (NCEP2)
- Japanese 25-year Reanalysis (JRA-25)
- the new NASA reanalysis (MERRA)

### Observations:

- TOA radiation fluxes, Cloud Cover and TPW: Clouds and the Earth's Radiant Energy System (CERES).
- Precipitation: Global Precipitation Climatology Project (GPCP) and CPC Merged Analysis of Precipitation (CMAP).

## Parameters shown in LW-SW domain and spatial domain



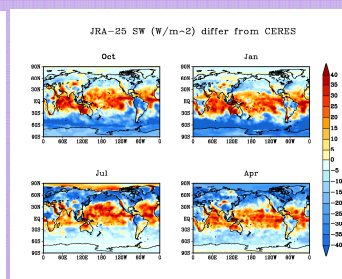
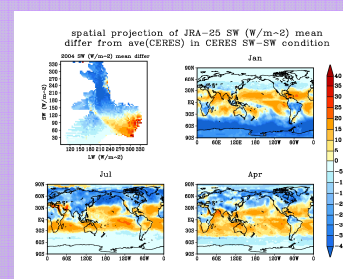
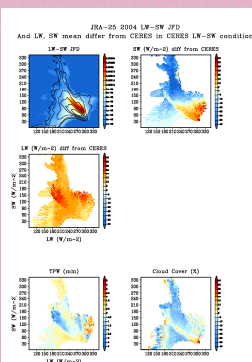
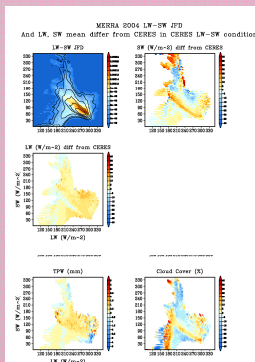
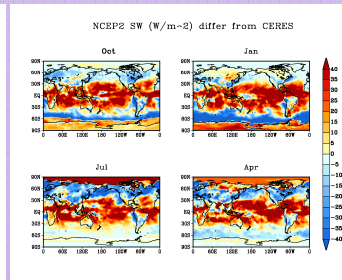
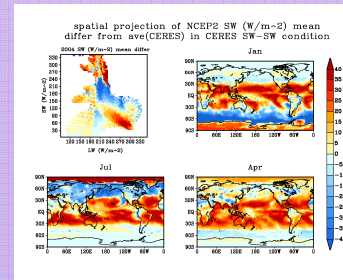
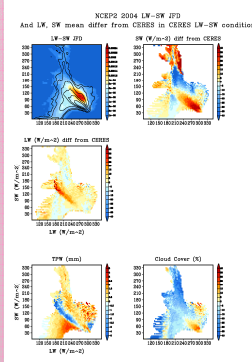
- It appears that the deviation of reanalyses data from independent observation are more significant in the LW-SW domain than in the spatial domain.
- Why choose TOA LW and SW fluxes as the bases of the domain? Because TOA LW and SW fluxes are associated with almost all the parameters and processes in the column of atmosphere, also because the existence of independent observation of TOA fluxes from ERBE and CERES.

## Project the biases in LW-SW domain back to spatial domain

The similarity between projection and real difference shows that the biases are associated with the state of LW-SW condition and it is valid to use LW and SW as the bases to represent the state of atmosphere.

## Why the shape and location of LW-SW JFDs are different

- The biases of LW and SW in the LW-SW domain of CERES observation explain why the shape and location of JFDs are different.
- Furthermore, Biases in TPW and cloud cover can roughly explain the biases in LW and SW.



## Conclusion

- Above analysis process can be used as a metric to evaluate the performance of reanalysis (or model). TOA LW and SW fluxes are the domain bases of this metric to interpret the interrelationships among water and energy parameters.
- MERRA performs better in comparison with other current reanalyses. Although space of improvement still exists.